

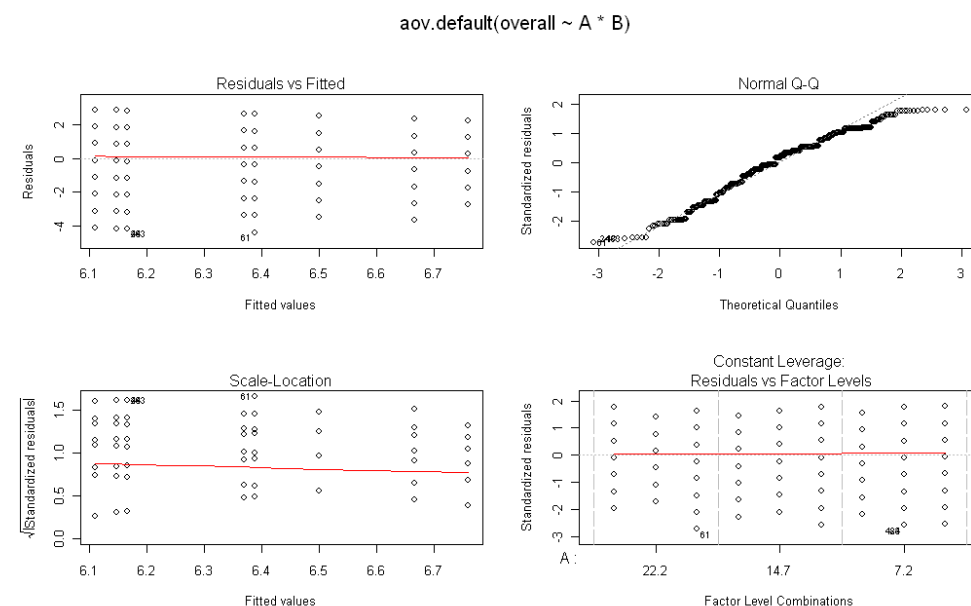
Overall

```
>library(DoE.base)
>nozzle <- fac.design(nfactors= 2,replications= 54,repeat.only=FALSE,randomize= F,seed=
24024 ,nlevels=c(3,3),factor.names=list(A=c(7.2,14.7,22.2),B=c(8,10,12)))
>overall<-c(5,5,6,4,4,5,6,6,4,5,5,7,4,7,6,6,3,6,3,9,7,7,3,2,5,2,2,9,7,7,7,6,7,5,4,7,6,4,4,7,8,5,5,6,7,7,
8,7,7,8,7,7,6,8,6,8,7,6,5,3,2,3,5,6,7,7,6,5,7,7,7,8,7,7,7,7,7,7,9,8,8,9,8,8,7,8,8,6,8,7,6,7,8,6,8,
8,3,6,5,5,6,6,9,8,4,4,5,8,6,3,7,5,7,8,8,6,8,6,6,7,7,6,7,8,8,9,8,8,8,8,8,6,7,7,8,6,4,4,5,9,8,8,7,8,7,8,
7,7,7,4,7,6,5,8,5,6,4,3,7,9,9,9,8,8,9,8,8,6,8,7,8,8,8,8,7,7,7,7,7,6,7,8,7,7,7,7,7,6,6,6,7,7,7,8,7,
6,7,7,8,8,9,6,4,7,4,4,8,3,6,7,5,7,7,4,7,7,5,6,8,7,7,6,7,7,7,6,5,9,9,9,8,8,7,8,8,7,6,6,4,6,6,6,4,6,9,9,
8,9,8,8,9,9,9,5,8,4,8,8,7,9,7,7,7,6,5,6,6,6,7,7,6,6,6,7,7,6,7,6,5,6,6,6,7,5,6,6,5,9,8,8,9,9,9,9,9,
7,6,7,7,7,6,7,6,7,4,7,5,6,7,5,8,8,8,3,5,7,8,7,5,7,5,2,4,8,8,5,8,8,7,5,6,5,6,7,8,4,6,3,4,5,5,5,6,7,5,6,6,
6,6,5,7,6,7,6,6,7,6,5,4,3,7,6,6,4,3,7,6,3,6,4,4,5,5,4,6,6,8,5,4,8,6,7,5,7,4,4,5,3,4,3,3,4,3,4,5,3,8,7,
5,4,6,2,8,8,8,8,8,9,9,8,8,8,8,6,8,7,5,8,7,6,6,6,7,6,7,6,6,7,5,7,6,5,5,4,5,5,4,6,7,7,7,8,5,8,6,7,6,8,8,
8,7,7,5,6,4,7,7,7,7,8,8,8,8,7,3,5,4,6,4,2,5,3,3)
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	2	2.83	1.4136	0.5403	0.5829
B	2	5.35	2.6728	1.0216	0.3608
A:B	4	16.42	4.1049	1.5690	0.1814
Residuals	477	1247.94	2.6162		

```
>nozzle$overall<-overall
>nozzle.aov<-aov(overall~A*B,data=nozzle)
>summary(nozzle.aov)
```

```
> oldpar<-par(oma=c(0,0,3,0),mfrow=c(2,2))
> plot(nozzle.aov)
> par(oldpar)
```



```
>nozzle <- fac.design(nfactors= 2,replications= 52,repeat.only=FALSE,randomize= F,seed=
```

```
24024 ,nlevels=c(3,3),factor.names=list(A=c(7.2,14.7,22.2),B=c(8,10,12)))
>overall<-c(5,5,6,4,4,5,6,6,4,5,5,7,4,7,6,6,3,6,3,9,7,7,3,2,5,2,2,9,7,7,7,6,7,5,4,7,6,4,4,7,8,5,5,6,7,7,
8,7,7,8,7,7,6,8,6,7,7,6,5,7,7,7,7,8,7,7,7,7,7,7,9,8,8,9,8,8,7,8,8,6,8,7,6,7,8,6,8,8,3,6,5,5,6,6,9,8,
4,4,5,8,6,3,7,5,7,8,8,6,8,6,6,7,7,6,7,8,8,9,8,8,8,8,8,6,7,7,8,6,4,4,5,9,8,8,7,8,7,8,7,7,7,4,7,6,5,8,5,
6,4,3,7,9,9,9,8,8,9,8,8,6,8,7,8,8,8,8,7,7,7,7,7,6,7,8,7,7,7,7,7,6,6,6,6,7,7,7,8,7,6,7,7,8,8,9,6,4,7,
4,4,8,3,6,7,5,7,7,4,7,7,5,6,8,7,7,6,7,7,7,6,5,9,9,9,9,8,8,7,8,8,7,6,6,4,6,6,6,4,6,9,9,8,9,8,8,9,9,5,8,
4,8,8,7,9,7,7,7,6,5,6,6,6,6,7,7,6,6,6,7,7,6,7,6,5,6,6,6,7,5,6,6,5,9,8,8,9,9,9,9,9,7,6,7,7,7,6,7,6,7,
4,7,5,6,7,5,8,8,8,3,5,7,8,7,5,7,5,2,4,8,8,5,8,8,7,5,6,5,6,7,8,4,6,3,4,5,5,5,6,7,5,6,6,6,6,5,7,6,7,6,6,7,
6,5,4,3,7,6,6,4,3,7,6,3,6,4,4,5,5,4,6,6,8,5,4,8,6,7,5,7,4,4,5,3,4,3,3,3,4,3,4,5,3,8,7,5,4,6,2,8,8,8,8,8,
9,9,8,8,8,8,6,8,7,5,8,7,6,6,6,7,6,7,6,6,7,5,7,6,5,5,4,5,5,5,4,6,7,7,7,8,5,8,6,7,6,8,8,8,7,7,5,6,4,7,7,7,
7,8,8,8,8,7)
```

```
>nozzle$overall<-overall
```

```
>nozzle.aov<-aov(overall~A*B,data=nozzle)
```

```
>summary(nozzle.aov)
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	2	2.13	1.0662	0.4310	0.6501
B	2	3.31	1.6560	0.6694	0.5125
A:B	4	12.28	3.0694	1.2408	0.2928
Residuals	459	1135.48	2.4738		

```
percentcows<- rep(c(rep(c(7.2),times=3),rep(c(14.7),times=3),rep(c(22.2),times=3)),times=52)
```

```
percentkiwi<- rep(c(rep(c(8),times=1),rep(c(10),times=1),rep(c(12),times=1)),times=156)
```

```
nozzle.rsm <- data.frame(percentcows,percentkiwi,overall)
```

```
nozzle.rsm
```

```
> library(rsm)
```

```
> nozzle.CR <- coded.data(nozzle.rsm,x1~(percentcows-14.7)/7.5,x2~(percentkiwi-10)/2)
```

```
> nozzle.rs<- rsm(overall ~ SO(x1,x2), data=nozzle.CR)
```

```
> summary (nozzle.rs)
```

Call:

```
rsm(formula = overall ~ SO(x1, x2), data = nozzle.CR)
```

Residuals:

	Min	1Q	Median	3Q	Max
	-4.4209	-0.7046	0.4573	1.4188	2.9252

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	6.53632	0.16257	40.207	<2e-16 ***
x1	-0.08013	0.08904	-0.900	0.369
x2	-0.08013	0.08904	-0.900	0.369
x1:x2	-0.15385	0.10905	-1.411	0.159
x1^2	-0.11218	0.15422	-0.727	0.467
x2^2	-0.03526	0.15422	-0.229	0.819

```
---
```

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
 Residual standard error: 1.573 on 462 degrees of freedom
 Multiple R-squared: 0.00899, Adjusted R-squared: -0.001735
 F-statistic: 0.8382 on 5 and 462 DF, p-value: 0.523

Analysis of Variance Table

Response: overall

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
FO(x1, x2)	2	4.01	2.0032	0.8098	0.4456
TWI(x1, x2)	1	4.92	4.9231	1.9902	0.1590
PQ(x1, x2)	2	1.44	0.7190	0.2907	0.7479
Residuals	462	1142.84	2.4737		
Lack of fit	3	7.35	2.4516	0.9910	0.3968
Pure error	459	1135.48	2.4738		

Stationary point of response surface:

x1	x2
-0.8507853	0.7198953

Stationary point in original units:

percentcows	percentkiwi
8.31911	11.43979

Eigenanalysis:

\$values

[1] 0.01228467 -0.15972056

\$vectors

	[,1]	[,2]
[1,]	0.5257311	-0.8506508
[2,]	-0.8506508	-0.5257311

```
> nozzle.rs<- rsm(overall ~ FO(x1,x2)+TWI(x1,x2), data=nozzle.CR)
> summary (nozzle.rs)
```

Call:

rsm(formula = overall ~ FO(x1, x2) + TWI(x1, x2), data = nozzle.CR)

Residuals:

Min	1Q	Median	3Q	Max
-4.3579	-0.7249	0.4081	1.4081	2.8761

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	6.43803	0.07259	88.689	<2e-16 ***
x1	-0.08013	0.08891	-0.901	0.368
x2	-0.08013	0.08891	-0.901	0.368
x1:x2	-0.15385	0.10889	-1.413	0.158

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
 Residual standard error: 1.57 on 464 degrees of freedom

Multiple R-squared: 0.007743, Adjusted R-squared: 0.001328

F-statistic: 1.207 on 3 and 464 DF, p-value: 0.3067

Analysis of Variance Table

Response: overall

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
FO(x1, x2)	2	4.01	2.0032	0.8123	0.4445
TWI(x1, x2)	1	4.92	4.9231	1.9963	0.1584
Residuals	464	1144.27	2.4661		
Lack of fit	5	8.79	1.7585	0.7109	0.6155
Pure error	459	1135.48	2.4738		

Stationary point of response surface:

x1	x2
-0.5208333	-0.5208333

Stationary point in original units:

percentcows	percentkiwi
10.793750	8.958333

Eigenanalysis:

\$values

[1] 0.07692308 -0.07692308

\$vectors

	[,1]	[,2]
[1,]	-0.7071068	-0.7071068
[2,]	0.7071068	-0.7071068

```
> nozzle.rs<- rsm(overall ~ FO(x1,x2), data=nozzle.CR)
```

```
> summary (nozzle.rs)
```

Call:

```
rsm(formula = overall ~ FO(x1, x2), data = nozzle.CR)
```

Residuals:

Min	1Q	Median	3Q	Max
-4.3579	-0.7682	0.4818	1.4217	2.7222

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	6.43803	0.07267	88.6	<2e-16 ***
x1	-0.08013	0.08900	-0.9	0.368
x2	-0.08013	0.08900	-0.9	0.368

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.572 on 465 degrees of freedom

Multiple R-squared: 0.003474, Adjusted R-squared: -0.000812

F-statistic: 0.8106 on 2 and 465 DF, p-value: 0.4452

Analysis of Variance Table

Response: overall

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
FO(x1, x2)	2	4.01	2.0032	0.8106	0.4452
Residuals	465	1149.20	2.4714		
Lack of fit	6	13.72	2.2860	0.9241	0.4772
Pure error	459	1135.48	2.4738		

Direction of steepest ascent (at radius 1):

x1	x2
-0.7071068	-0.7071068

Corresponding increment in original units:

percentcows	percentkiwi
-5.303301	-1.414214

(FO+TWI is the best model)

```
par(mfrow=c(1,2))
```

```
persp(nozzle.rs,~x1+x2,col=rainbow(50),contours="colors",xlab=c("percentcows(x1)","percentkiwi(x2)"), zlab="response",cex.lab=1.2)
```

```
contour(nozzle.rs,~x1+x2,col=rainbow(10),xlab=c("percentcows(x1)","percentkiwi(x2)"),labcex=1.5)
```

